Budget and Mineral Revenues in Botswana

Author’s Details:

(1) Refilwe Ngwako-Faculty of Commerce, BA ISAGO University, P. Bag 149 Suite # 268, Kgale View Postnet, Gaborone, Botswana. refngwako@yahoo.co.uk/refilwe.ngwako@baisago.ac.bw

(2) Mufaro A. Matandare-Faculty of Commerce, BA ISAGO University, P. Bag 149 Suite # 268, Kgale View Postnet, Gaborone, Botswana. mmatandare1@gmail.com/mufaro.matandare@baisago.ac.bw

Abstract: Policy makers have been interested in the area of public finance especially in the issue of potential links among and between government expenditure and revenue. On one side, the access to tax revenue accumulation presents difficulties due to a narrow tax base as most people in developing countries are low-income earners and tax collection is marred by several loopholes. On the other side, developing countries government expenditures are constantly increasing as they aspire for economic development. This poses a challenge for developing countries given shocks in their main revenue sources. The paper analyses the dynamic relationship between budget, mineral revenue shocks (main revenue source for Botswana) and other major macroeconomic variables in Botswana by applying a VAR approach. It uses quarterly data points from 1995; Q1 to 2011: Q3. Results show that a shock in government expenditure points to a negative relationship between this variable and the revenue variables. This suggests that as the government spends it reduces the tax holdings of the country. It is thus recommended that prudent spending should be done in order to minimize the effects of revenue shocks. Furthermore, an expansionary fiscal policy should ensure that crowding out is kept in check.

Keywords: Government expenditure, Tax Revenue, mineral revenue, VAR, Botswana

1.0 Introduction

Botswana’s prudent and stable macro-economic policies have earned her the position of a middle income economy in 1997. Her fiscal policy is based on some rules putting much emphasis on limiting total public expenditure, containing budget deficits within reasonable limits, and ensuring that the revenues from diamonds are put to productive use (BoB, 2000). Amidst this excellent economic performance, there has been rapid growth in government spending. The trend throughout the 1990s and early 2000s have been one in which government spending has been increasing quite rapidly (Botswana Financial statistics, 2004). The main factors leading to this increase in government size include spending on military or defense, education, which is free and health expenditure.

In as much as this has been a good economic record the 2007/08 global financial crisis did not spare Botswana from its dire consequences as she like other nations experienced dwindling economic growth. This was also witnessed in its budget deficits in years following the crisis which stood at 13.4 billion in 2009/10, 12.118 billion in 2010/11 (GoB, 2009, 2010, 2011). The main cause of this trend was deterioration in the terms of trade. Put differently, a sharp fall in the price of diamonds and an increase in the import prices, more especially, oil, led to this. This in turn, as mentioned earlier, subsequently led to the shrinking of the country’s revenue base.

Maintaining a fiscal surplus is therefore important because when the economy is under financial strain it can be able to utilize sparingly what it has been accumulating in the form of reserves over the booming period. In recent times however the country has been faced with a fiscal deficit from 2008 as mentioned earlier. This aside tarnishing the good image of the country reverses the efforts that have been dedicated to maintaining fiscal balances. Therefore the serious consequences of budget deficits and limited availability of studies on this issue necessitate an investigation of the shock in mineral revenues and its effect on the government budget as well as the response of other macroeconomic variables to this shock.

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The objective of this study is to investigate the impact of the government budget constraint on mineral revenue as well as the macroeconomy of Botswana. Period of study chosen (1995: Q1 to 2011: Q3) covers both periods of budget deficits and budget surpluses. Given that the government budget constraint provides an accounting identity within which taxes, expenditure and sources of financing fiscal imbalances are linked together, results of such a study can be widely used in issues of policy analysis. This study will, therefore, guide scholars as well as the country’s economic diversification drive going forth.

2.0 Literature Review

A fiscal balance prevails in the economy when the amounts of expenditures match the available revenues but when revenue falls short of expenditure the economy incurs a budget deficit. If revenues are in excess of expenditure then the economy is facing a budget surplus. There are three schools of thought pertaining to the economic effects of budget deficits on the economy namely Neoclassical, Keynesian, and Ricardian approaches. The analysis of these approaches is based on the IS/LM macroeconomic model (aggregate demand-aggregate supply model) where budget deficits are treated as exogenous (Saad and Kalakech, 2009).

2.1 Neo-classicism and Keynesian paradigms

The Neo-classicals together with the Keynesians are of the view that when employment is at less than full potential the increase in the budget deficit, resulting from either increasing government spending or a tax cut, will increase national income (Saad and Kalakech 2009). In other words government issues bonds to finance its deficits resulting in the net wealth rise because of interest payments on bonds. The aggregate demand for goods and services increases since consumption is a function of income. Economic theory has it that this will cause an increase in transactional demand for money. However, when the government issues bonds to cover its deficit, the demand for credits increases relative to supply. In order to attract savings, the government may offer higher interest rates which reduce private investment spending causing what is called a “crowding out” effect (Bernheim, 1989). Therefore, deficit spending might stifle the rate of capital formation and hence, economic growth.

Monetization can also be used to finance a fiscal deficit but this has an inflationary impact since there will be an excess of money in the economy for which demand does not exist. This will distort purchasing power and restore it people increase their nominal money holdings increasing the demand for money. Thus, an inflationary deficit financing leads to an additional demand for money. Periods of high inflation are characterised by people converting their money holdings into forms that are more resistant to inflation such as foreign currency.

In spite of the fact that Neoclassical and Keynesian views assume the same implications of budget deficits on money demand in the short run. Neo-classicals stipulate that the economy will be at a full employment level of output in the long-run. At this level, the output will be independent of budget deficits since the increase in wealth offsets a reduction in other private expenditure. As a result, budget deficits have no effect on money demand in the long-run (Yellen, 1989).

2.2 The Ricardian Equivalence Proposition

The Ricardian Neutrality made famous by Barro (1974) and Ricardo (1817) posits that government debt is not considered to be a part of the society’s net wealth but that debt is a deferred tax. It argues that a tax cut budget deficit or/and an increased spending deficit, financed by interest-bearing government’s bonds, is interpreted by consumers as a deferred tax whose present value is equal to the current deficit. Therefore, consumers will increase their savings, expecting that the government will increase the future tax to pay back its debt. This
basically implies that borrowing to finance a deficit in the present period and imposing taxes on the present generation to finance government expenditure have the same effect owing to the fact that the burden of the deficit is to be borne by the current generation (Howard, 2001).

 Aggregate demand does not change since government spending increased by the same amount as consumption decreased. Consequently, output levels do not change and the economy is unaffected (Barro, 1989). Besides aggregate demand, this hypothesis further posits that budget deficit has no impact on interest rates, inflation and money demand in both the long and short runs (Vamvouks, 1998; Bernheim 1989).

2.3 Empirical literature review on the effects of budget deficits

Over the past years, scholars, as well as researchers, have explored the relationships between shocks and the macroeconomic performance of national economies. Different methods of analysis have yielded a different result. Some of the results of the studies have contradicting results to the theories while some are indeed what has been put forward by the theories.

Research work on the matter at hand has looked at both country specific and cross country levels and includes studies such as those done by Hoelscher (1986); Zahid (1988); Darat (1989); Melvin et. al (1989); Devereux (1995); Ibrahim and Kumar (1996); Koru and Ozmen (2003); San and Su (2003); Akpan (2009); Saad and Kalakech (2009); Hauner and Kumar (2011); Eltony (2011). Since these studies were an attempt to provide insights as to the effects that a budget deficit has on the macroeconomic variables they can be useful to the proposed study and hence have a sizeable payoff on future economic policy in Botswana.

Hoelscher (1986) analysed the connection between deficits and long-term interest rates for the period from 1953 to 1984 in the United States. The regression results indicated that this deficit-interest rate connection is strong, robust, and very significant. Since long-term rates are more closely related to many consumer and business spending decisions than are short-term rates, the crowding-out effects of deficit spending are potentially serious. The presence of the link was also confirmed by Zahid (1988). He found that as long as the government budget deficit is defined to reflect the government excess demand for funds from the nongovernment Public, and the counter-cyclical variations in the deficit figures are adjusted for, then a significant positive impact of deficits on real interest rates in the U.S. during the period 1971-80 does indeed exist. The notion that the definition of a fiscal deficit is important was also pointed out by Hauner and Kumar (2011) where they state that budget deficits have a significant but small effect on long-term rates and that this result depends on the fiscal concept used, as only expected deficits, but not past or current deficits or debt have a significant effect.

On the contrary, Darrat (1989) still in the United States in the context of annual data covering the period 1946 through 1986 rejected the aforementioned proposition. Instead, the author found support for the reverse hypothesis that long-term interest rates have caused significant changes in the deficit measures. Therefore, the finding of a significant correlation between the two variables by Hoelscher (1986) cannot be used to infer support for the conventional view. In fact, the results of this paper are consistent with the Ricardian Neutrality and thus bring about further doubts on the presence of significant crowding-out effects for budget deficits.

Studies have also looked at the relationship between government deficits and real exchange rates. One of them is by Melvin et. Al (1989) whose evidence presented that large shifts in the size of the United States federal budget deficit have a significant effect on the real foreign exchange value of the dollar. They established that expected deficits in the early 1980s led to the depreciation of the dollar. The results indicate the importance of using measures of the expected future deficit. Though having two different results Devereux (1995) also was in part supporting this view. In his model, the impact of an announced future deficit depended on the elasticity of intertemporal substitution. If it is high, an announced deficit gives rise to immediate real exchange rate
appreciation. When a low elasticity of inter-temporal substitution exists, however, an announced deficit may generate a real depreciation. This finding was true, despite the fact that the economy did not exhibit Ricardian equivalence, owing to the presence of finite-horizon consumers. Moreover, in this case, the announcement of a future deficit will increase the intertemporal volatility of the real exchange rate but leave its average value unaffected.

However, San and Su (2003) examined the relationship between budget deficits and exchange rates in seven Asian countries and eight Euro-currency countries over the years from 1951 to 2001. Applying the Time-Series Cross-Section Regression with the Seemingly Unrelated Regression approach to data from 15 countries, the results indicate that because of the indirect effect of the expected inflation rate, the risk premium, and the expected return rate, currency values are inversely related to budget deficits. However, the empirical results also present evidence supporting the Ricardian Equivalence Proposition that there is no direct effect of budget deficits on exchange rates.

Following the work of Koru and Ozmen (2003), no direct link between budget deficits and inflation was found to exist because according to the budget deficits exogenously determine money growth. Still, on the issue of inflation, Saad and Kalakech (2009) echoed a different view attributing a rise in inflation to a budget deficit. They have shown that budget deficits may lead to instability in the economy due to the expectations about how to finance the deficits. For instance, if the private sector expects that the government will use the monetary policy to finance the deficit; this will lead to inflation even though the government does not monetize the deficit. As a result, the private investment will suffer from the crowding out effect leading to reduced output growth. This situation will push prices up resulting in inflation.

Nigeria is highly vulnerable to fluctuations in the international oil market despite being the 6th largest producer of oil in the world. This motivated Akpan (2009) to conduct a study on oil price shocks and the macroeconomy using a VAR model. The variance decomposition showed that the response of real government expenditure to a one standard deviation shock to positive oil price changes was significantly different from zero. Shocks to inflation contributed an average of 5 percent to real exchange rate shocks. The result of the study indicates that government expenditures fall at the onset but increase significantly owing to the sticky nature of government expenditures in Nigeria.

In an effort to remedy the omission of some macro-economic variables in many studies Ibrahim and Kumar (1996) applied VARs and cointegration to study the short- and long-run relationships among macroeconomic variables. These are budget deficits, money interest rates, exchange rates, and the current account balance. The results suggested that a larger proportion of variations in the interest rate differential current account balances of countries are explained by monetary innovations rather than by fiscal innovations. However, fluctuations in real exchange rates were better accounted for by fiscal innovations.

Eltony (2011) like Ibrahim and Kumar (1996) examined how macroeconomic variables collectively react to fluctuations in the world oil prices. He used three different versions of VAR, namely, the unrestricted VAR, the Vector Error Correction Model, and the Structural VAR. The three versions yielded qualitatively similar results. Generally, the results indicated that shocks to oil prices and hence to oil revenues are very important in explaining most of the forecast errors variance of the government expenditure, however, government development expenditure has been more responsive to oil shocks than current expenditure. Furthermore, the results clearly showed the importance of both types of government expenditure in explaining the forecast errors variance of the Consumer Price Index (CPI). Thus, fiscal policy as represented by government expenditure appears to be effective. Shocks to government expenditures account for a relatively large proportion of the CPI variance. This conclusion is not surprising and is actually consistent with what is expected in a country in which the government is the sole owner of the main national income source, the oil and gas industry. Thus,
government expenditure becomes the major determinant of the level of economic activity and the mechanism by which the government can affect the circular flow of income within the economy.

From the review of literature, we come to the view that both traditional and contemporary theoretical and empirical literature propose and found out conflicting evidence on the relationship between our major variables of interest: government expenditure and revenue. It can also be broadly summarized that only a few studies are available on the nexus between these variables especially with regards to emerging countries.

3.0 Methodology

This section discusses the method of data analysis which is a VECM, derived from a VAR. Diagnostics for these two methods of modeling time series data will also be discussed.

3.1 Model specification

In investigating the response of macroeconomic variables (interest rate, real exchange rate, inflation, tax revenue, and government expenditure) to innovations in revenues from mining a restricted Vector Autoregressive model (VAR) is adopted. This is also known as a Vector Error Correction Model (VECM) and it is derived from a VAR. It provides a multivariate framework where changes in a particular variable, mineral revenues let’s say, are related to changes in its own lags and to changes in other variables and the lags of those variables. In addition to this, economic theory is sometimes not rich enough to provide a dynamic specification that meets all these relationships hence the use of a VECM in the proposed study cannot be over-emphasized.

A VAR treats all variables as endogenous, expressing the dependent variables in terms of predetermined lagged variables; it is a reduced-form model (Enders, 2010). Thus a structural VAR of order k can be specified as;

\[ Y_t = A_o + A_1 Y_{t-1} + \ldots + A_p Y_{t-k} + e_t \]  

(3.1)

In matrix form it is written as;

\[
\begin{bmatrix}
Y_{t}\nY_{t-1}\nY_{t-2}\n\vdots\nY_{t-p}\n\end{bmatrix}
= \begin{bmatrix}
A_0 & A_1 & A_2 & \ldots & A_p
\end{bmatrix}
\begin{bmatrix}
Y_{t-1}\nY_{t-2}\nY_{t-3}\n\vdots\nY_{t-p}\n\end{bmatrix}
+ \begin{bmatrix}
A_0 & A_1 & A_2 & \ldots & A_p
\end{bmatrix}
\begin{bmatrix}
Y_{t-1}\nY_{t-2}\nY_{t-3}\n\vdots\nY_{t-p}\n\end{bmatrix}
+ \begin{bmatrix}
e_t\n\end{bmatrix}
\]

(3.2)

Where \( Y_t \) is a vector of endogenous variables \( A_o \), is a vector of constants, \( A_1, \ldots, A_p \) is the \( p \times p \) matrices of coefficients to be estimated, \( p \) is the number of variables considered in the system \( k \) is the lag length \( e_t \) is a vector of innovations following zero mean white-noise with a time invariant positive-definitive variance-covariance matrix. In terms of the anticipated study, therefore, the vector of endogenous variables consists of: government expenditure (GEX), nominal interest rate (INT), a nominal exchange rate(EXC), core inflation(INF), tax revenue (TAXREV). The theory behind the model has been explained in the section preceding this one. In VAR representation the function for the study can be written as,
The dummy variable for structural breaks in the economy as shown by periods of surpluses and deficits is represented by column vector $D$ where $D = 1$ for surpluses and 0 otherwise.

### 3.2 Data analysis techniques for a VAR

In line with developments in time series modelling, unit root tests on the relevant economic variables in the model should be performed to determine their time series characteristics. These tests are basically required to ascertain the number of times a variable has to be differenced to arrive at stationarity. The reasoning here is that there is the problem of ‘spurious regression’ when non-stationary series are estimated at their levels in a stochastic equation. It follows, therefore, that knowing the order of integration of macroeconomic variables helps in a model specification.

Fairly sophisticated methods are available to evaluate the time series characteristics of macro variables (Egwaikhede, 1994). Some of the currently employed methods are the Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and the Phillips Peron (PP) tests which the present study used. Other diagnostics to be performed include the lag exclusion test which helps choose if the model without lags is viable or not and if we should use a model without lags and the LM test will test for residual serial correlation. Tests for normality and residual heteroskedasticity will be performed.

### 3.3 Vector Error Correction model (VECM)

Most Economic variables are known to be non-stationary, for example, interest rates, and at the same time can have a cointegrating relationship which justifies the use of a VECM. This, therefore, implies that even if the stability condition of a VAR fails the process may still be analysed. The VEC specification restricts the long run behaviour of the endogenous variables to converge to their cointegrating relationship while allowing a wide range of short run dynamics. Using equation (3.1) we subtract $Y_{t-1}$ from both sides to obtain the VECM model and then re-arranging (3.1) can thus be specified as,

$$
\Delta X_t = \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{p-1} \Delta X_{t-p+1} + \epsilon_t
$$

(3.4)

Should the stability conditions fail to hold then (3.2) becomes;
\[
\begin{align*}
\Delta \text{TAXREV}_{t_1} & \quad \Delta GEX_{t_2} \\
\Delta \text{INF}_{t_3} & \quad \Delta \text{EXC}_{t_4} \\
\Delta \text{INF}_{t_5} & \quad \Delta \text{INF}_{t_5, p-1} \\
\end{align*}
\]
\[= \Pi \begin{bmatrix}
\text{TAXREV}_{t_1-1} \\
\text{GEX}_{t_2-1} \\
\text{INT}_{t_3-1} \\
\text{EXC}_{t_4-1} \\
\text{INF}_{t_5-1} \\
\end{bmatrix} + \Gamma_1 \begin{bmatrix}
\Delta \text{TAXREV}_{t_1-1} \\
\Delta GEX_{t_2-1} \\
\Delta \text{INT}_{t_3-1} \\
\Delta \text{EXC}_{t_4-1} \\
\Delta \text{INF}_{t_5, p-1} \\
\end{bmatrix} + \Gamma_2 \begin{bmatrix}
\Delta \text{TAXREV}_{t_1, p-1} \\
\Delta GEX_{t_2, p-1} \\
\Delta \text{INT}_{t_3, p-1} \\
\Delta \text{EXC}_{t_4, p-1} \\
\Delta \text{INF}_{t_5, p-1} \\
\end{bmatrix} + \ldots + \Gamma_{p-1} \begin{bmatrix}
\Delta \text{TAXREV}_{t_1, p-1} \\
\Delta GEX_{t_2, p-1} \\
\Delta \text{INT}_{t_3, p-1} \\
\Delta \text{EXC}_{t_4, p-1} \\
\Delta \text{INF}_{t_5, p-1} \\
\end{bmatrix} + \begin{bmatrix}
D_1 \\
D_2 \\
D_3 \\
D_4 \\
D_5 \\
\end{bmatrix}
\]
\[(3.5)\]

Where:
\(\Delta\) is the difference operator
\(\Pi = -(I-A_{i+1} + \ldots + A_p)\) for \(i = 1,2,3,p-1\). \(\Pi\) and \(\Gamma\) are \((n \times n)\) coefficients of matrices. By assumption \(X_i\) in (3.4) does not contain stochastic trends because of \(x_i \sim I(1)\). Thus the term \(\Pi X_{t-1}\) is the only one that includes \(I(1)\) variables hence it must be \(I(0)\). This implies that it must contain a cointergrating relationship. It is often referred to as the long-term part or error correction term of the model.

\(\Gamma_j = -(A_{j+1} + \ldots + A_p)\) For \(j=1,\ldots,p-1\) are short term parameters that determine the short-run movements of the variables (Luketpolh, 2007). Deviations from the long run equilibrium are corrected gradually through a series of partial short-run adjustments from these parameters.

**3.4 Data analysis techniques for a VEC**

In the VEC the author assesses the order of intergration of the variables, plots for linear trend and checks if the variables are cointegrated of the same order or multi-cointegrated. As mentioned earlier VEC specification only applies to cointegrated series, the Johansen cointergration test should be done prior to the specification of the VEC. This allows to confirm that the variables are cointegrated and to determine the number of cointergrating equations. In making inferences about the number of cointergrating relations the trace and the maximum eigenvalue statistics will be used (Enders, 2010).

Once the VECM has been estimated, the relative importance of each variable in generating variations in its own value and in the value of other variables is assessed using Forecast Error Variance Decomposition (VDC). VDC assesses the relative importance of revenue shocks in the volatility of other variables in the system. The dynamic response of macroeconomic variables to innovations in a particular variable can also be traced out using the Impulse Response Functions (IRF) (Greene, 2003). Thus, the IRF enables the determination of the dynamic effects of shocks on the Botswana macroeconomy.

**3.5 Data and data sources**

The paper proposes the use of time series data covering a period of 17 years from 1995: Q1 to 2011: Q3. The data will be mainly obtained from Quarterly series of the Botswana Financial Statistics published by the Bank of Botswana with the help of The Central Statistics Office. All the data analysis was done using E-VIEWS.
4.0 Empirical Results

Since the ARDL bounds test breaks down when any of the variables are integrated of an order greater than 1, there is need to confirm the order of integration for each variable with the aid of unit root tests. In this study, the unit root tests were conducted using the Augmented Dickey-Fuller Generalised Least Square, the Perron (1997) PPURoot (to cater for structural breaks) unit root tests and the Ng-Perron Modified Unit Root Test. The unit root results of the variables are shown in Table 1 and the associated breakpoints as given by the Perron (1997) PPURoot test are given in Table 2.

4.1 Empirical results

Khim and Liew (2004) suggest that when the sample size is less than 120 the AIC and FPE turns out to be the better choice as compared to the other procedures when selecting the appropriate lag length. We, therefore, chose 4 lags as theory suggests that wide lag lengths are preferred to small ones. However, when estimating a VECM we chose 3 lags to minimise the AIC (Lutkepohl, 2007). The lag exclusion test has also confirmed the use of lags in the model by rejecting the null of a restricted model (model without lags) at 5% level of significance. Stability conditions were satisfied as no root was found to lie outside the unit circle. The Jarque-Bera statistic indicates that we reject the null that residuals are multivariate normal, implying that they are not normally distributed.

4.2 Unit Root Tests

The method of estimation of the standard regression model, Ordinary Least Square (OLS) method, is based on the assumption that the means and variances of the variables being tested are constant over the time (Enders, 2010). Variables whose means and variances change over time are known as non-stationary or unit root variables. Therefore, incorporating non-stationary or unit root variables in estimating the regression equations using the OLS method give misleading inferences. The results obtained by using non-stationary time series may be spurious in that they may indicate a relationship between two variables where one does not exist. In order to receive consistent, reliable results, the non-stationary data needs to be transformed into stationary data. This is our case is done with the ADF and PP and results for the tests are summarized in table 1 below.

It is depicted in Table 1 that when variables are tested for a unit root with both trends and intercept we fail to reject the hypothesis that the series contains a unit root at 5% significance level for all the variables except inflation, mineral revenue and tax revenue which were all found to be I(0). In the first scenario however where tests were conducted with neither a constant nor intercept. Tax revenue and the real exchange rate were found to be I(0) while all other members of the series rejected the null of a unit root at 5% and 10% level of significance which makes them I(1) variables. These results were confirmed by the PP test.
Table 1: Unit Root Tests

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF</th>
<th>PP</th>
<th>Order of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Levels</td>
<td>1st diff</td>
<td>2nd diff</td>
</tr>
<tr>
<td>lnexc</td>
<td>-2.286*</td>
<td>-7.326*</td>
<td>-10.033*</td>
</tr>
<tr>
<td>lngex</td>
<td>5.119</td>
<td>-2.088**</td>
<td>-10.127*</td>
</tr>
<tr>
<td>lnint</td>
<td>-0.089</td>
<td>-5.866*</td>
<td>-13.210*</td>
</tr>
<tr>
<td>lnmin_rev</td>
<td>0.6112</td>
<td>-12.777*</td>
<td>-7.431*</td>
</tr>
<tr>
<td>lnaxrev</td>
<td>-16.610*</td>
<td>-7.048*</td>
<td>-7.256*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Levels</td>
<td>1st diff</td>
<td>2nd diff</td>
</tr>
<tr>
<td>lnexc</td>
<td>1.553</td>
<td>-6.972*</td>
<td>-10.197*</td>
</tr>
<tr>
<td>lngex</td>
<td>-1.873</td>
<td>-10.056*</td>
<td>-9.965*</td>
</tr>
<tr>
<td>lninf</td>
<td>-0.820**</td>
<td>-6.299*</td>
<td>-6.683*</td>
</tr>
<tr>
<td>lnint</td>
<td>-0.940*</td>
<td>-5.665*</td>
<td>-13.423*</td>
</tr>
<tr>
<td>lnmin_rev</td>
<td>-5.742*</td>
<td>-12.637*</td>
<td>-7.316*</td>
</tr>
<tr>
<td>lnaxrev</td>
<td>-16.770*</td>
<td>-6.957*</td>
<td>-7.128*</td>
</tr>
</tbody>
</table>

**Stationary at 5% and 10% ;* Stationarity at 5% level of significance ;*** stationary at 5% and 10% level of significance but non-stationary at 1% level of significance.

4.3 Cointegrating Relations

Since most variables were found to be I (1), the next task would be to test for the presence of a long-run relationship between the variables using the Johansen-Juselius procedure. This test is based on the maximum likelihood estimation in a VAR model and it calculates two statistics – the trace statistic and the maximum Eigenvalue. The trace statistic in the Johansen procedure tests the null hypothesis that there are at most r cointegrating vectors against the hypothesis of r+1 cointegrating vectors. The maximum Eigenvalue statistic also tests for r cointegrating vectors against the hypothesis of r+1 cointegrating vectors (Chimobi, 2009). The number of cointegration equations for the series is summarised in Table 2 below:

Table 2: Cointegration test

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
<th>Max-Eigen Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>r=0</td>
<td>0.433258</td>
<td>95.40787</td>
<td>83.93712</td>
<td>0.0058</td>
<td>35.20676</td>
<td>36.63019</td>
<td>0.0726</td>
</tr>
<tr>
<td>r≥1 *</td>
<td>0.30467</td>
<td>60.20111</td>
<td>60.06141</td>
<td>0.0487</td>
<td>22.52887</td>
<td>30.43961</td>
<td>0.3458</td>
</tr>
<tr>
<td>r ≥2</td>
<td>0.238766</td>
<td>37.67224</td>
<td>40.17493</td>
<td>0.0874</td>
<td>16.91447</td>
<td>24.15921</td>
<td>0.3489</td>
</tr>
<tr>
<td>r≥ 3</td>
<td>0.183603</td>
<td>20.75777</td>
<td>24.27596</td>
<td>0.1304</td>
<td>12.57698</td>
<td>17.7973</td>
<td>0.2563</td>
</tr>
<tr>
<td>r ≥4</td>
<td>0.123241</td>
<td>8.180783</td>
<td>12.3209</td>
<td>0.223</td>
<td>8.154423</td>
<td>11.2248</td>
<td>0.1648</td>
</tr>
<tr>
<td>r ≥ 5</td>
<td>0.000425</td>
<td>0.02636</td>
<td>4.129906</td>
<td>0.8944</td>
<td>0.02636</td>
<td>4.129906</td>
<td>0.8944</td>
</tr>
</tbody>
</table>
The trace statistic fails to reject the null of no cointegration (r=0) at 5% level of significance. However, the hypothesis of at most 1 cointegrating equation (r \geq 1) is not rejected at 5% level of significance indicating the presence of 1 cointegrating vector. The maximum eigenvalue likewise fails to reject the null of no cointegration (r=0) at 5% level of significance but fails to reject the null of at most 1 cointegrating equation (r \geq 1). Presence of a cointegrating vector implies that we can then go ahead and estimate the impulse response functions and the variance decomposition functions which show the short run as well as the long run dynamics.

**Figure 4.1: Impulse response functions from Government Expenditure Innovations**

A shock in GEX as shown in figure 4.1 above indicates a negative relationship between GEX and the 2 revenue variables as shown on panels (e) and (f). This suggests that as the government spends it reduces the tax holdings of the country. It could also be interpreted as deficit spending since while GEX is rising TAXREV is reducing. INF fluctuates between positives and negatives. All the other variables besides GEX itself which reacts positively from shocks on itself show a negative impact.
Figure 4.5: Impulse response functions from Tax Revenue Innovations

(a) Response of LN_TAXREV to LN_TAXREV
(b) Response of LN_EXC to LN_TAXREV
(c) Response of LN_INT to LN_TAXREV
(d) Response of LN_INF to LN_TAXREV
(e) Response of LN_GEX to LN_TAXREV
(f) Response of LN_MIN_REV to LN_TAXREV

Diagrams above show that TAXREV is positively related to shocks imposed on itself. MINREV and GEX are inversely related to shocks in TAXREV with the later depicting this relationship only in the 25th quarter and becoming positive in the rest of the forecasting horizon. EXC and INT show an inverse relationship in the short-run and a positive one for most of the period. INF in panel (d) is only positively related to shocks on TAXREV in the 1st quarter and then becomes negatively affected in the rest of the period.

4.4 Variance decomposition

Variance decomposition separates the variation in an endogenous variable into the component shocks to the VECM. It provides information about the relative importance of each random innovation in affecting the variables in the VECM. Put differently it sheds light on how the variables in the model explain fluctuations in mineral revenue. It is however expected in applied research however for a variable to explain all its forecast error variance at short horizons and smaller proportions at longer horizons (Enders, 2010).
Table 4.3: Variance decomposition for Government Expenditure

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>LN_GEX</th>
<th>LN_MINREV</th>
<th>LN_TAXREV</th>
<th>LN_INF</th>
<th>LN_INT</th>
<th>LN_EXC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.104985</td>
<td>97.80056</td>
<td>0</td>
<td>0.996256</td>
<td>2.013432</td>
<td>0.007694</td>
<td>0.068501</td>
</tr>
<tr>
<td>5</td>
<td>0.154729</td>
<td>77.2578</td>
<td>3.374617</td>
<td>2.996812</td>
<td>4.995346</td>
<td>0.289033</td>
<td>2.927781</td>
</tr>
<tr>
<td>10</td>
<td>0.197141</td>
<td>70.83549</td>
<td>3.357865</td>
<td>3.94553</td>
<td>5.345946</td>
<td>1.19009</td>
<td>2.185444</td>
</tr>
<tr>
<td>15</td>
<td>0.230179</td>
<td>69.44321</td>
<td>3.193995</td>
<td>4.66601</td>
<td>4.72048</td>
<td>1.827702</td>
<td>1.99491</td>
</tr>
<tr>
<td>20</td>
<td>0.259081</td>
<td>69.02774</td>
<td>3.048375</td>
<td>5.219253</td>
<td>4.16533</td>
<td>1.839522</td>
<td>1.83222</td>
</tr>
</tbody>
</table>

Table 4.3 shows GEX has a huge impact on the shocks to itself contributing about 68% of the variations in the long-term. The variation accounted for by all the other variables is less pronounced.

Table 4.4: Variance decomposition for Tax Revenue

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>LN_TAXREV</th>
<th>LN_GEX</th>
<th>LN_MINREV</th>
<th>LN_INF</th>
<th>LN_INT</th>
<th>LN_EXC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.433336</td>
<td>91.67417</td>
<td>0</td>
<td>0</td>
<td>1.522889</td>
<td>11.14622</td>
<td>0.06576</td>
</tr>
<tr>
<td>5</td>
<td>0.611884</td>
<td>75.66397</td>
<td>3.658976</td>
<td>3.031137</td>
<td>33.84096</td>
<td>2.459284</td>
<td>0.392062</td>
</tr>
<tr>
<td>10</td>
<td>0.751505</td>
<td>66.68127</td>
<td>5.594928</td>
<td>2.962182</td>
<td>31.03947</td>
<td>1.77558</td>
<td>0.25382</td>
</tr>
<tr>
<td>15</td>
<td>0.864837</td>
<td>61.51411</td>
<td>5.466633</td>
<td>2.878694</td>
<td>29.96612</td>
<td>1.996249</td>
<td>0.274761</td>
</tr>
<tr>
<td>20</td>
<td>0.947901</td>
<td>58.25568</td>
<td>5.206038</td>
<td>3.030898</td>
<td>28.34921</td>
<td>1.76326</td>
<td>0.238438</td>
</tr>
<tr>
<td>25</td>
<td>1.028877</td>
<td>56.78341</td>
<td>4.534411</td>
<td>2.952202</td>
<td>27.41849</td>
<td>1.816706</td>
<td>0.216154</td>
</tr>
<tr>
<td>30</td>
<td>1.09806</td>
<td>55.33953</td>
<td>4.064927</td>
<td>2.893406</td>
<td>26.84934</td>
<td>1.708994</td>
<td>0.198028</td>
</tr>
<tr>
<td>35</td>
<td>1.166104</td>
<td>54.48349</td>
<td>3.739517</td>
<td>2.831099</td>
<td>26.20669</td>
<td>1.724588</td>
<td>0.182451</td>
</tr>
<tr>
<td>40</td>
<td>1.269011</td>
<td>53.55256</td>
<td>3.415066</td>
<td>2.809936</td>
<td>25.90015</td>
<td>1.667873</td>
<td>0.168489</td>
</tr>
<tr>
<td>45</td>
<td>1.286287</td>
<td>52.90434</td>
<td>3.179203</td>
<td>2.779793</td>
<td>25.43546</td>
<td>1.671579</td>
<td>0.158331</td>
</tr>
<tr>
<td>50</td>
<td>1.341544</td>
<td>52.2697</td>
<td>2.966891</td>
<td>2.761161</td>
<td>25.23842</td>
<td>1.638931</td>
<td>0.150088</td>
</tr>
<tr>
<td>55</td>
<td>1.395657</td>
<td>51.81232</td>
<td>2.804793</td>
<td>2.73871</td>
<td>24.90115</td>
<td>1.638042</td>
<td>0.143562</td>
</tr>
<tr>
<td>60</td>
<td>1.447139</td>
<td>51.37828</td>
<td>2.658446</td>
<td>2.724783</td>
<td>24.75548</td>
<td>1.618047</td>
<td>0.13814</td>
</tr>
<tr>
<td>65</td>
<td>1.497348</td>
<td>51.03445</td>
<td>2.540591</td>
<td>2.708763</td>
<td>24.50791</td>
<td>1.61541</td>
<td>0.133492</td>
</tr>
</tbody>
</table>

For the case of TAXREV, in the long run, most variations are accounted for by INF at 24%. MINREV and TAXREV account for 3% each with other variables being less significant.

5.0 Conclusion
This paper analyses the dynamic relationship between mineral revenue shocks and major macroeconomic variables in Botswana by applying a VAR approach. It uses quarterly data points from 1995: Q1 to 2011: Q3. A VECM was run and Impulse response functions were generated. The results show that a shock in Government
expenditure points to a negative relationship between this variable and the revenue variables. This suggests that as the government spends, it reduces the tax holdings of the country. It could also be interpreted as deficit spending since government spending is rising at the expense of tax revenue. Prudent spending is thus recommended in order to minimize the effects of revenue shocks. As far as variance decompositions are concerned, it was shown that the variations in mineral revenues and government expenditures are explained by fiscal innovations. A large proportion of the variations in tax revenue, on the other hand, were explained by monetary innovations. It was also indicated in the results that shock to government expenditure raises interest rates leading to the crowding out of the private sector. It is thus recommended that expansionary fiscal policy should ensure that crowding out is kept in check.

References


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